AD-A102 740 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON --ETC F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LOWER KAKEOUT DAM (NJ00822 PASSAIC--ETC(U)
JUL 81 R J MCDERMOTT, J E GRIBBIN DACW61-79-C-0011
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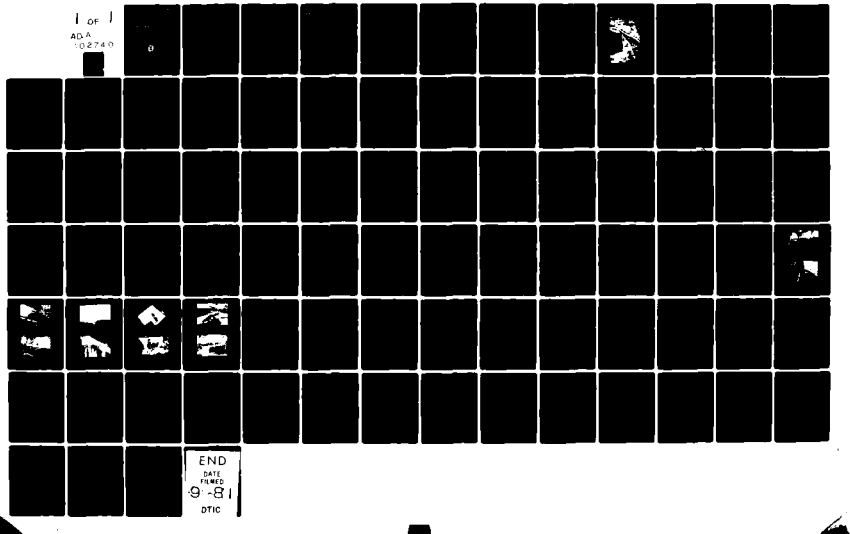

PASSAIC RIVER BASIN
STONE HOUSE BROOK, MORRIS COUNTY
NEW JERSEY

LOWER KAKEOUT DAM
NJ00822

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Lower Kakeout Dam (NJ00822 Passaic River Basin,
Stone House Brook, Morris County, New Jersey.
Phase 1 Inspection Report.

(15) DACW61-79-C-0011

Richard J. /McDermott
John E. /Gribbin

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

JUL 1981

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National Dam Safety Program
Passaic River Basin, NJ
Stone House Brook, NJ
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Spillways
Leakage

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-N

27 JUL 1981

Honorable [illegible]
Governor of New Jersey
Trenton, New Jersey 08625

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lower Kakeout Dam, Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Lower Kakeout Dam, a high hazard potential structure, is judged to be in poor overall condition. The dam's spillway is considered inadequate since it cannot discharge a flow equivalent to 3 percent of the Spillway Design Flood (SDF) without causing the dam to be overtopped. (The SDF, in this instance, is one-half of the Probable Maximum Flood). The decision to classify the dam as "inadequate" instead of "seriously inadequate" is based on the fact that the failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam over that which would exist just prior to failure. To ensure adequate protection until adequate spillway capacity can be provided, it is recommended that:

a. The spillway adequacy should be determined by a qualified professional engineer employed by the owner using more sophisticated methodology than that used in the Phase I investigation. This study should be completed within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to correct any deficiency in spillway adequacy should be initiated.

b. Within one year from the date of approval of this report the owner should institute a program to have the observed leakage monitored on a periodic basis by a professional engineer experienced in the design and construction of dams in order to detect any changes in volume or condition. Also, each time the impoundment is drawn down or diverted, the entire concrete dam structure should be thoroughly inspected and evaluated for distress not observed during the Phase I inspection and the structure should be repaired as required.

NAPEN-N
Honorable Brendan T. Byrne

c. Within twelve months from the date of approval of this report, the following remedial actions should be completed:

(1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

(2) All spalled, cracked and otherwise deteriorated surfaces of the dam should be thoroughly repaired.

d. The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

e. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box 2809
Trenton, NJ 08625

Mr. [illegible]
Director
Division of Water Resources
N.J. Dept. of Environmental Protection

LOWER KAKEOUT DAM (NJ00822)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 18 December 1980 by Storch Engineers, under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lower Kakeout Dam, a high hazard potential structure, is judged to be in poor overall condition. The dam's spillway is considered inadequate because a flow equivalent to 5 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from the date of approval of this report the owner should initiate a program to have the observed leakage monitored on a periodic basis by a professional engineer experienced in the design and construction of dams in order to detect any changes in volume or condition. Also, with the impoundment drawn down or diverted, the entire concrete dam structure should be thoroughly inspected and evaluated for distress not observed during the Phase I inspection and the structure should be repaired accordingly.

c. Within two years from the date of approval of this report, the following remedial actions should be completed:

(1) The [illegible] weirs should be investigated with respect to operational adequacy and then restored to proper operational condition.

(2) All spalled, cracked and otherwise deteriorated surfaces of the dam should be [illegible] repaired.

d. The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

e. The owner should develop written operating procedures and a periodic maintenance plan for the safety of the dam, within one year from the date of approval of this report.

Submitted: [signature]

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

Date: 22 Jan 81

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lower Kakeout Dam, I.D. NJ00822
State Located:	New Jersey
County Located:	Morris
Drainage Basin:	Passaic River
Stream:	Stone House Brook
Date of Inspection:	December 18, 1980

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Lower Kakeout Dam is assessed as being in poor overall condition.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge capacity of the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam. (The SDF for Lower Kakeout Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing approximately 1 percent of the PMF or 2 percent of the SDF. Therefore, the owner should engage a professional engineer experienced in the design and construction of dams in the near future to perform more accurate hydraulic and hydrologic analyses relating to the spillway capacity. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

Also, with the impoundment drawn down or diverted, the entire concrete dam structure should be thoroughly inspected and evaluated for distress not observed during the Phase I inspection and the structure should be repaired accordingly.

The observed leakage should be monitored on a periodic basis by a professional engineer experienced in the design and construction dams in order to detect any changes in volume or condition.

In addition, it is recommended that the following remedial measures be undertaken in the near future:

1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

2) All spalled, cracked and otherwise deteriorated surfaces of the dam should be thoroughly repaired.

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.

OVERVIEW - LOWER KAKEOUT DAM

20 JANUARY 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydraulic and hydrologic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydraulic and hydrologic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

LOWER KAKEOUT DAM, I.D. NJ00822

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Lower Kakeout Dam was made on December 18, 1980. The purpose of inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description

The dam is a concrete gravity dam with a notched spillover section near its center. Immediately downstream from the spillway section a concrete apron is located.

The outlet works consist of gated 24-inch and 6-inch cast iron pipes which transversely penetrate the dam approximately 50 feet to the right of the spillway. The gates are located on the downstream side of the dam.

Between the concrete apron and the outlet works, the area immediately downstream from the toe of dam is stabilized by boulders. At the left end of the dam a concrete and brick gate house is located.

The elevation of the spillway crest is 659.0, National Geodetic Vertical Datum (N.G.V.D.), while that of the crest of dam is 660.0. The invert of the outlet works is 644.4 and the stream bed elevation at the toe of dam is 643.2. The overall length of dam is 170 feet and its height is 16.8 feet.

b. Location

Lower Kakeout Dam is located in the Township of Kinnelon, Morris County, New Jersey. It impounds a lake immediately downstream from Butler Reservoir. Principal access to the dam is by an unpaved road named Bubbling Brook Road which is entered from Kakeout Road. Discharge from the spillway of the dam flows into Stone House Brook, a tributary to the Pequannock River.

c. Size and Hazard Classification

The dam is classified in accordance with criteria presented in "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers. Size categories consist of Small, Intermediate and Large while hazard categories are designated as Low, Significant and High.

Size Classification: Lower Kakeout Dam is classified as "Small" size since its maximum storage volume is 53 acre-feet (which is less than 1000 acre-feet) and its height is 16.8 feet (which is less than 40 feet).

Hazard Classification: Visual inspection of the downstream flood plain of the dam together with breach analysis indicate that failure of the dam could inundate the dwellings located along the downstream channel bank approximately 900 feet from the dam. Loss of more than a few lives is possible. Accordingly, Lower Kakeout Dam is classifed as "High" hazard.

d. Ownership

Lower Kakeout Dam is owned by the Borough of Butler, 10 High Street, Butler, New Jersey 07405.

e. Purpose of Dam

Although the original purpose of the dam was the impoundment of a water supply reservoir facility, reportedly at the present time the dam is of no use.

f. Design and Construction History

Reportedly, Lower Kakeout Dam was constructed during the period between 1900 and 1932.

g. Normal Operational Procedures

Operation and maintenance of the dam is under the jurisdiction of the Borough of Butler. Reportedly, no maintenance or operation is currently performed.

1.3 Pertinent Data

a. Drainage Area	5.93 square miles
b. Discharge at Damsite	
Maximum flood at damsite	Unknown
Outlet works at pool elevation	60 cfs
Spillway capacity at top of dam	148 cfs
c. Elevation (N.G.V.D.)	
Top of Dam	660.0
Maximum pool-design surcharge	664.8
Recreation pool	659.0
Spillway crest	659.0
Stream bed at toe of dam	643.2
Maximum tailwater	651 (Estimated)
d. Reservoir	
Length of maximum pool	1000 feet (Estimated)
Length of recreation pool	900 feet (Scaled)
e. Storage (Acre-feet)	
Recreation pool	41
Design surcharge	168
Top of dam	53

f. Reservoir Surface (acres)

Top of dam	4.8 (Estimated)
Maximum pool - design surcharge	5.0 (Estimated)
Recreation pool	4.6

g. Dam

Type	Concrete Gravity
Length	170 feet
Height	16.8 feet
Sideslopes - Upstream	1 horiz. to 5 vert.
- Downstream	Vertical (Approx.)
Zoning	N.A.
Impervious core	N.A.
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Concrete weir
Length of weir	49.5 feet
Crest elevation	659.0
Gates	N.A.
Approach channel	N.A.
Discharge channel	Natural stream

j. Regulating Outlet

24-inch and 6-inch diameter cast iron low-level outlet pipes controlled by gate valves at downstream side of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

No plans or calculations pertaining to the original design of the dam could be obtained.

2.2 Construction

No data or reports pertaining to the construction of the dam are available.

2.3 Operation

No data or reports pertaining to the operations of the dam are available.

2.4 Evaluation

a. Availablility

No data or reports pertaining to the operations of the dam are available.

b. Adequacy

Available engineering data pertaining to Lower Kakeout Dam is not adequate to be of significant assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

The validity of engineering data cannot be assessed due to the absence of data.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Lower Kakeout Dam was performed on December 18, 1980 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.

2) The embankment and accessible appurtenant structures were measured and key elevations determined by surveyor's level.

3) The embankment, appurtenant structures and adjacent areas were photographed.

4) The downstream flood plain was toured to evaluate downstream development and restricting structures.

b. Dam

No structural cracking or unusual movement of the dam was observed. However, severe surface deterioration of the concrete was noted. The downstream face from the spillway to the right end of the dam was spalled and cracked. The spalls were as deep as 0.6 feet. The crest on its downstream side was severely deteriorated from spalling and erosion from approximately the outlet works to the right end of the dam. The crest was also deteriorated for a distance of approximately 15 feet immediately to the left of the spillway.

The downstream face of the dam in the vicinity of the outlet pipe, in addition to being spalled was also scaled. There was evidence of significant exudation and incrustation.

Some spalling could be observed along the upstream face of the dam between the crest and the water level, however, it did not appear to be as severe as the spalling on the downstream side. However, there were some points where it was 3 to 4 inches deep and the spalling tended to run along horizontal lines. There was one location on the downstream face approximately 15 feet to the right of the outlet structure where some ice was emerging from the downstream face. This indicated some very slow leakage. The point where the ice was emerging is a point where there was considerable incrustation and possible exudation.

c. Appurtenant Structures

Downstream from the spillway apron, a small scoured section containing large boulders and serving a stilling basin was observed.

The gate house at the left end of dam was constructed with a concrete foundaton and brick walls above the foundation. Both the brick and the concrete appeared to be in satisfactory condition. A cast iron pipe with a valve at the end protrudes from a point near the base of the foundation approximately 3 feet downstream from the dam and the pipe was discharging at the time of inspection. The quantity of flow was approximately 10 to 20 gallons per minute.

A large vertical construction joint was observed on the downstream side of dam at the center of the spillway section. It was approximately 1 inch wide. The sound of flowing water could be heard within the joint.

An area of the apron was deteriorated, spalled and chipped away, about at the center of the apron at its interface with the downstream side of the dam. The area of deterioration measured approximately 5 feet by 3 feet. The left side of the deterioration coincided with the construction joint described above. Leakage could be observed emerging from the downstream face of the apron. A horizontal construction joint ran the entire length of the downstream face of the apron about 8 inches below the top surface. Seepage or leakage was dripping from this joint along almost its entire length. Seepage or leakage could also be observed trickling through the rocks at the downstream end of the apron adjacent to the right end of the apron.

The condition of the concrete of the gate housing for the outlet works was generally sound, although it was deteriorated by spalling and chipping at some of its edges and corners. A construction joint ran around the structure horizontally at the top of the outlet pipe and the joint appeared to be spalled and possibly opened up. The discharge end of the pipe appeared to be in satisfactory condition although the inside surface of the pipe was rusted with one large scale of rust visible. No leakage was flowing through the pipe, although there was about 2 inches of ice in the invert of the pipe. The concrete of the outlet structure was severely spalled just below the 6-inch pipe and ice was observed on the concrete surface indicating that some leakage occurs. The outlet gate operating mechanisms appeared to be intact and in workable condition. However, they were rusted and pitted and appeared to have not been operated in considerable time.

d. Downstream Channel

The downstream channel is a natural stream with a bed lined with boulders and very steep high banks on both sides. The stream is wooded along both banks and contains no significant obstructions.

e. Reservoir Area

The reservoir appeared to be entirely surrounded by woods. The shores slope steeply up from the reservoir at grades of about 50 percent.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in the Lower Kakeout Dam impoundment is regulated by discharge over the concrete spillway. At present the outlet works of the dam is not used to drain the lake or to augment the discharge capacity of the spillway.

Reportedly, operation of the impoundment as a water supply reservoir was discontinued in 1932.

4.2 Maintenance of the Dam

Reportedly, no maintenance is currently performed on the dam.

4.3 Maintenance of Operating Facilities

Reportedly, no maintenance is currently performed on operating facilities.

4.4 Description of Warning System

Reportedly, no warning system is currently in use for the dam.

4.5 Evaluation of Operational Adequacy

The operation of the dam has not been successful to the extent that the dam apparently is frequently overtopped.

Maintenance documentation is poor and maintenance has been inadequate in the following areas:

1) Outlet works not maintained in operational adequacy.
2) Spalled concrete and cracks on entire dam and appurtenant structures not repaired.
3) Leakage at outlet works not corrected.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff quantity, called the spillway design Flood (SDF), is described in terms of return frequency or Probable Maximum Flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Lower Kakeout Dam falls in a range of 1/2 PMF to PMF. In this case the low end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF peak computed for Lower Kakeout Dam is 5859 c.f.s. This value is derived from the 1/2 PMF hydrograph supplied for this analysis by the Corps of Engineers.

The spillway discharge rates were computed by the use of a weir formula appropriate for the configuration of the spillway. The total spillway discharge with lake level equal to the top of the dam was computed to be 148 c.f.s. The SDF was routed through the dam by use of the HEC-1-DAM computer program using the modified Puls Method. Hydrologic computations and computer output are contained in Appendix 4. In routing the SDF, it was found that the dam crest would be overtopped by a depth of 4.8 feet.

A dam breach analysis was then performed using a trapezoidal breach section with bottom length of 50 feet and sideslopes of 1 horizontal to 1 vertical. The breach peak outflow was computed

to be 6137 c.f.s. Breach computations are contained in Appendix 4. The analysis indicated that dam failure due to overtopping would not significantly increase the potential for loss of life over that which would exist without failure. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Experience data for the dam could not be obtained.

c. Visual Observation

The spalled and eroded condition of the dam crest, noted at the time of inspection, indicates the probability of frequent overtopping of the dam.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equal to the SDF would cause overtoping of the dam by a depth of 4.8 feet over the crest of the dam. The spillway is capable of passing approximately 2 percent of the SDF with the lake level equal to the top of dam.

e. Drawdown Data

Drawdown of the lake is accomplished by opening the gates in the 24 and 6-inch outlet pipes. Total time for drawdown is estimated to be about 1 day (See Appendix 4).

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam appeared, at the time of inspection to be outwardly structurally stable with no evidence of structural cracks or unusual movement observed. Evidence of leakage was observed at several locations on the dam and in the concrete apron area.

b. Generalized Soils Description

The generalized soils description for the dam site consists of recent alluvium composed of stratified materials deposited by streams overlying glacial ground moraine composed of unstratified material deposited during the Wisconsin glaciation.

c. Design and Construction Data

Analysis of structural stability and construction data for the dam are not available.

d. Operating Records

No operating records are available for the dam. The water level of the impoundment is not monitored.

Reportedly, operation of the impoundment as a water supply reservoir was discontinued in 1932.

e. Post-Construction Changes

Reportedly, it is not known whether or not there have been any post-construction changes. No evidence of significant post-construction changes was noted at the time of inspection.

f. Seismic Stability

Lower Kakeout Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. Lower Kakeout Dam appeared to be stable under static loading conditions at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Lower Kakeout Dam is assessed as being inadequate. The spillway is not able to pass the SDF without an overtopping of the dam.

The embankment appeared, at the time of inspection, to be outwardly structurally stable. Observed leakage and spalls in the dam structure are not considered to be evidence of immediate dam instability. However, the dam could become unstable if repairs are not implemented.

b. Adequacy of Information

Information sources for this report include 1) field inspections, 2) USGS quadrangle, and 3) consultation with personnel of the Butler Department of Public Works. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1. Construction and as-built drawings.
2. Construction progress reports.
3. Design computations and reports.
4. Soils report for the site.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Lower Kakeout Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is considered to be inadequate. It is therefore recommended that a professional engineer expereinced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses relating to spillway capacity. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

Also, with the impoundment drawn down or diverted, the entire concrete dam structure should be thoroughly inspected and evaluated for distress not observed during the Phase I inspection and the structure should be repaired accordingly.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

2) All spalled, cracked and otherwise deteriorated surfaces of the dam should be thoroughly repaired.

b. Maintenance

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

c. Additional Studies

The observed leakage should be monitored on a periodic basis by a professional engineer experienced in the design and construction of dams in order to detect any changes in volume or condition.

PLATES

LOWER KAKEOUT DAM

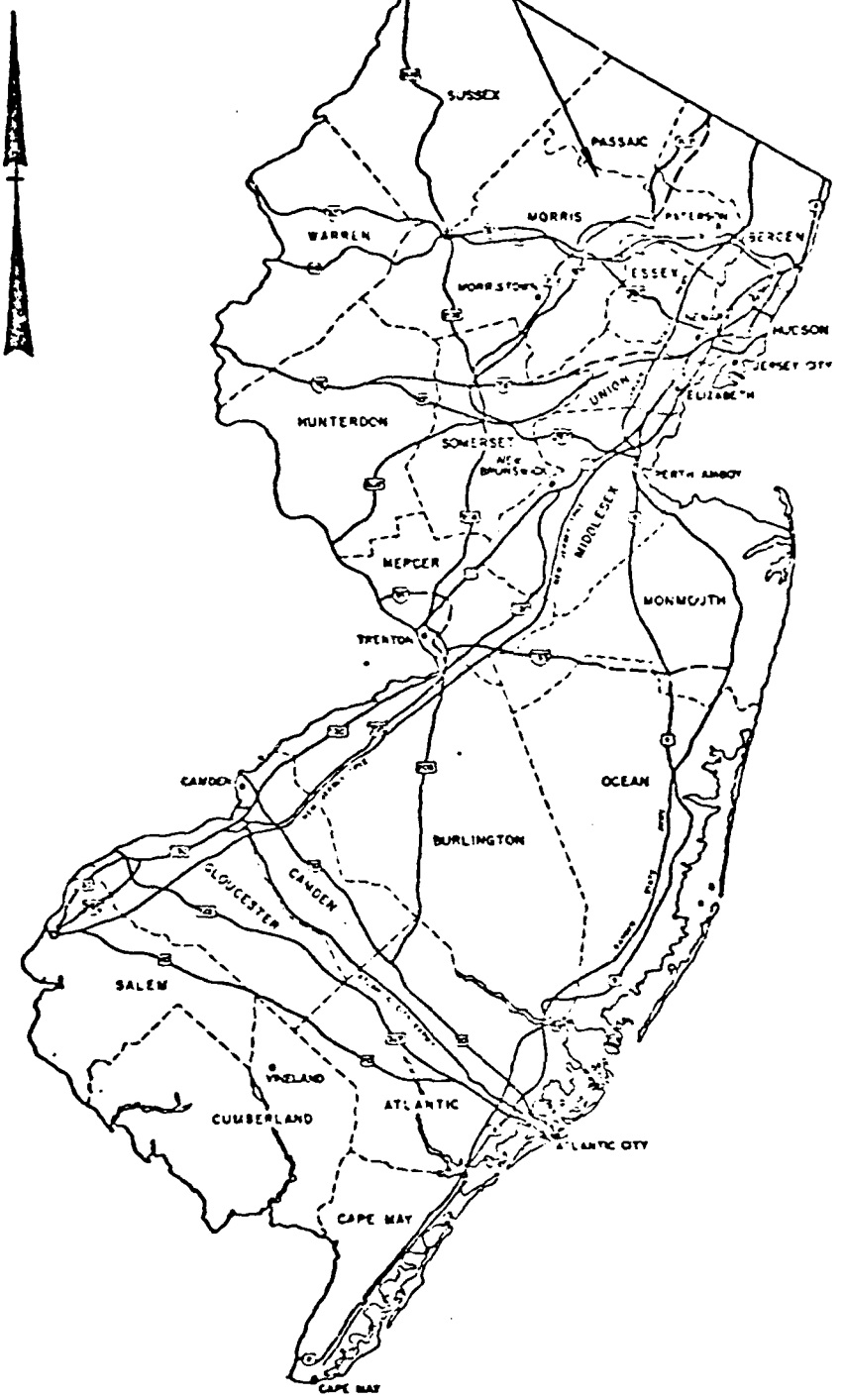


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP LOWER KAKEOUT DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	SCALE: NONE DATE: FEB. 1981

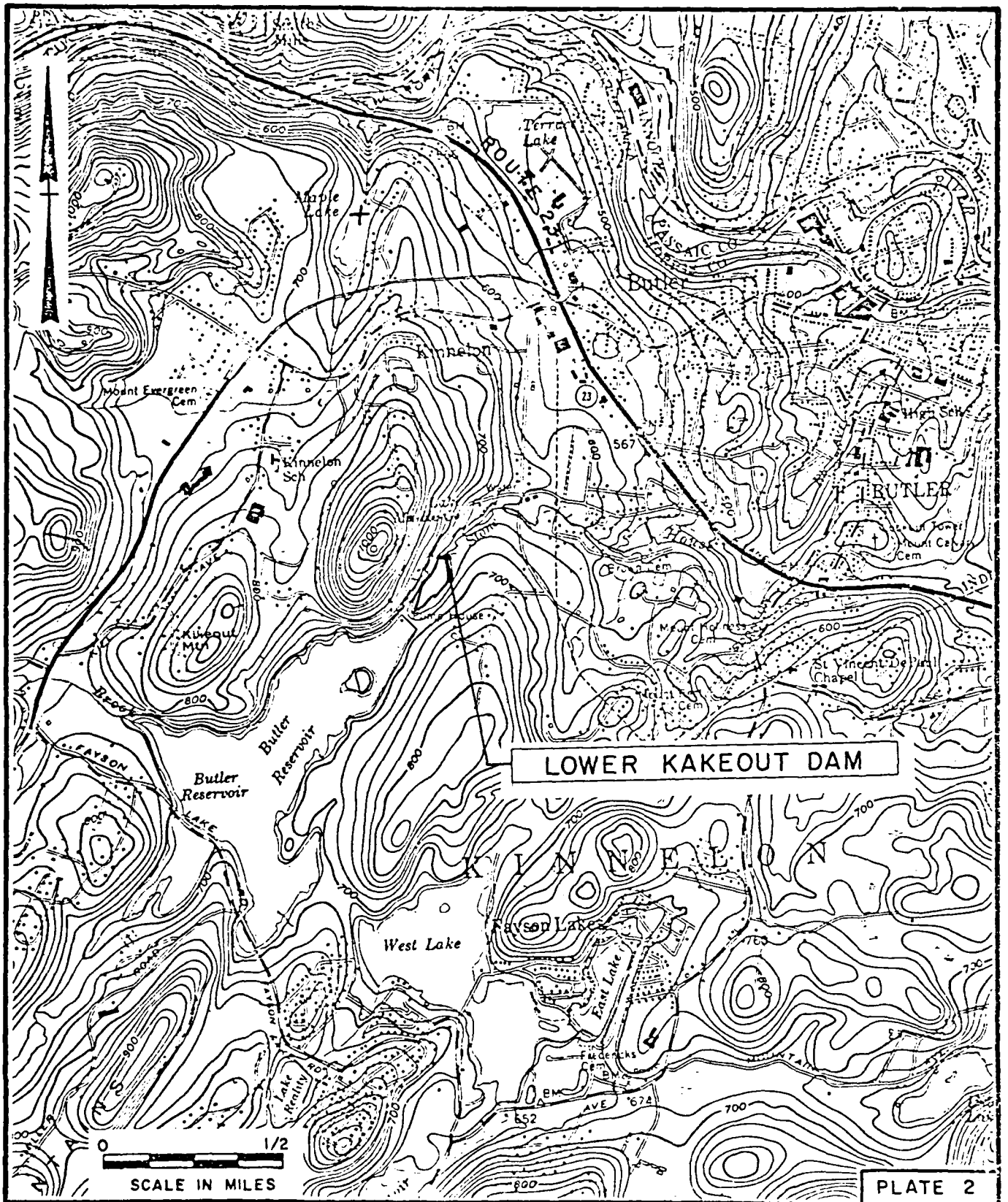


PLATE 2

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

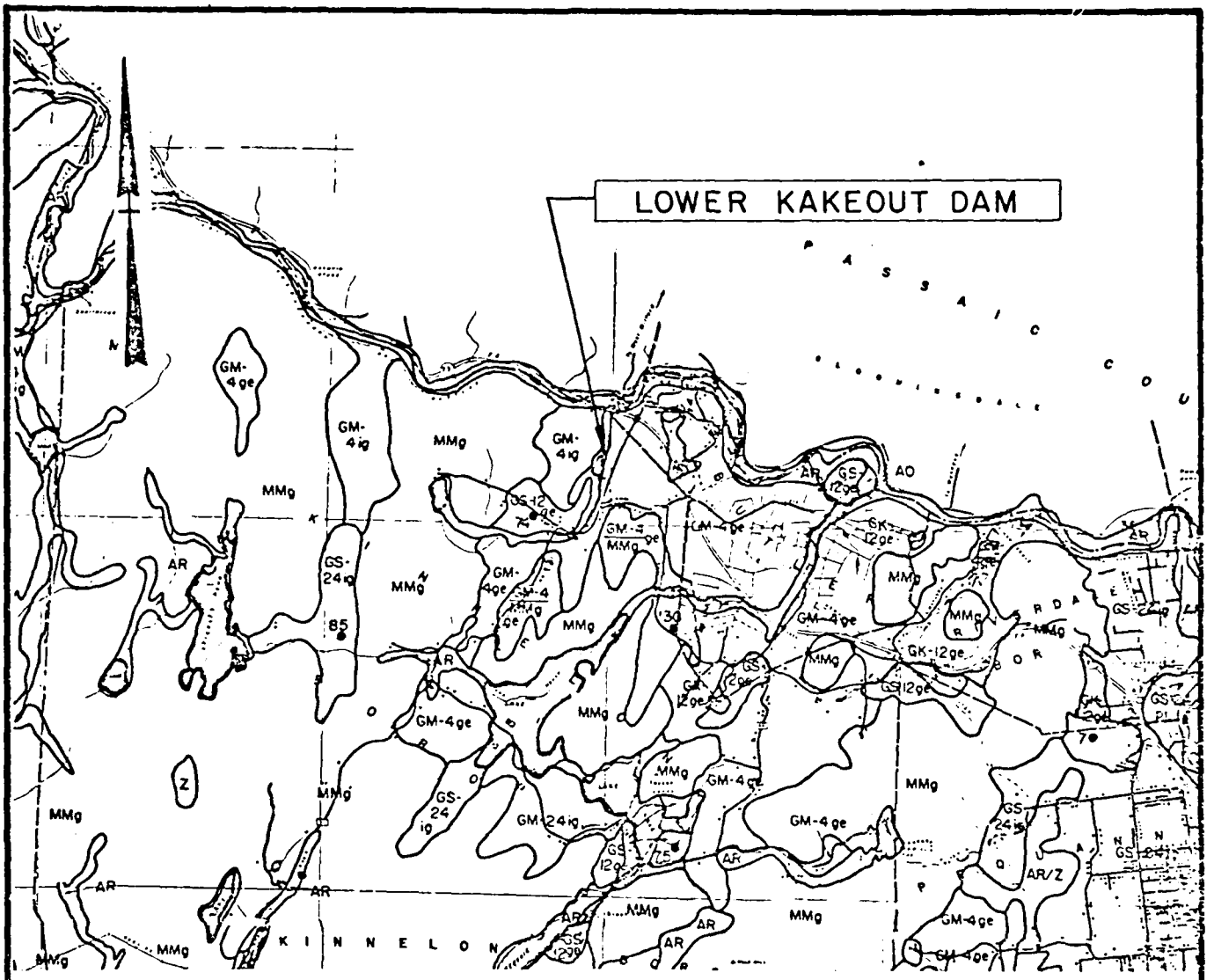
INSPECTION AND EVALUATION OF DAMS

VICINITY MAP

LOWER KAKEOUT DAM

SCALE: AS SHOWN

DATE: FEB. 1981



Legend

AR — Recent alluvium composed of stratified materials by streams.

GM-4 — Glacial ground moraine composed of unstratified m deposited during the Wisconsin glaciation.

Note: Information taken from: Rutgers University Engineering Soil Survey of New Jersey, Report No. 9, Morris County, November 1953 and Geologic Map of New Jersey prepared by J. V. Lewis and H. Kummel 1910-1912, revised by H. B. Kummel 1931 and M. Johnson 1950.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY.

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY.

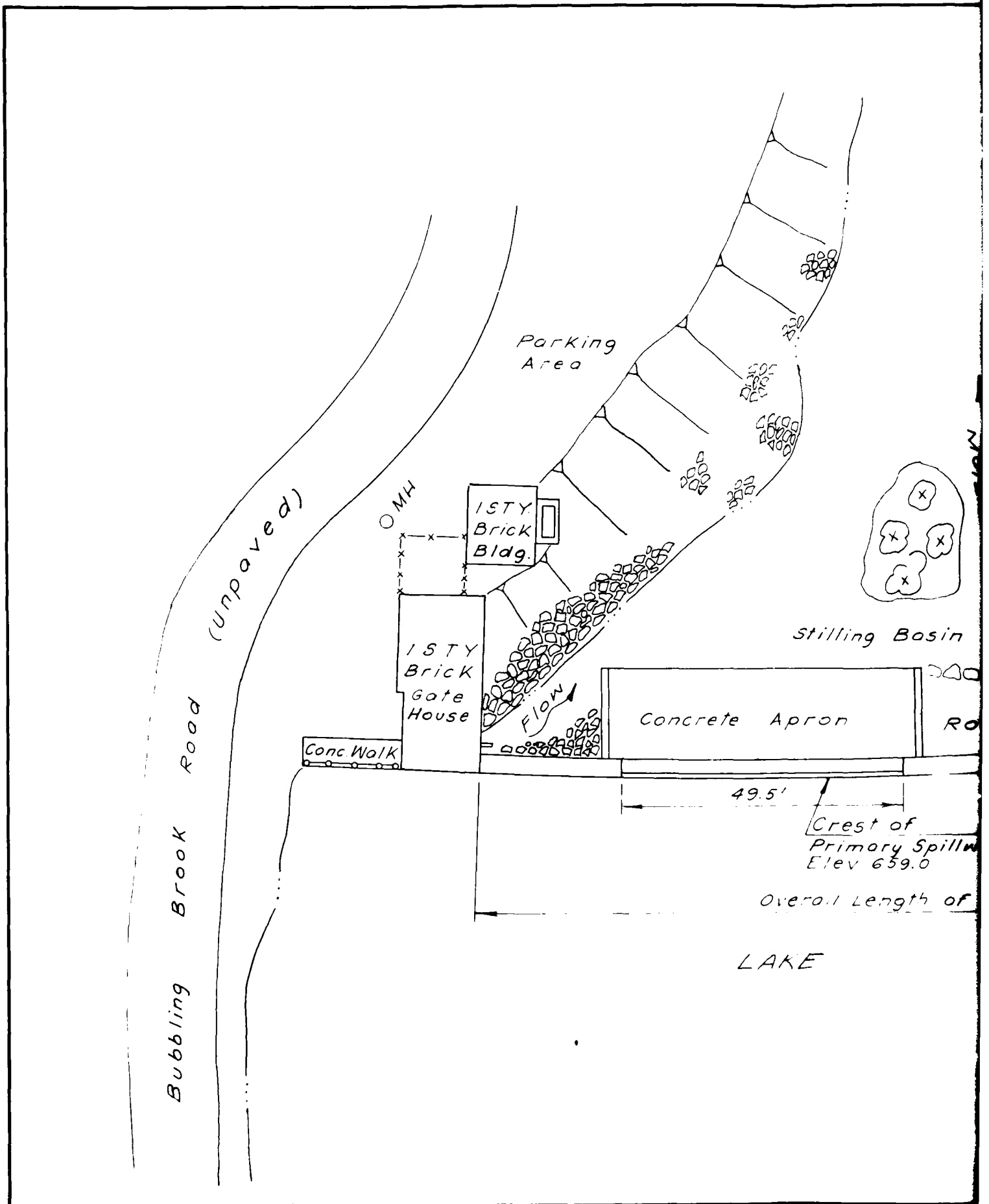
INSPECTION AND EVALUATION OF DAMS

SOIL MAP

LOWER KAKEOUT DAM

SCALE: NONE

DATE: FEB.1981


Parking
Area
MH
1 STY.
Brick
Bldg.
1 STY
Brick
Gate
House
Conc Walk
FLOW
Concrete Apron
Stilling Basin
49.5'
Crest of
Primory Spillw
Elev 659.0
Overall Length of
LAKE
Bubbling Brook Road (unpaved)

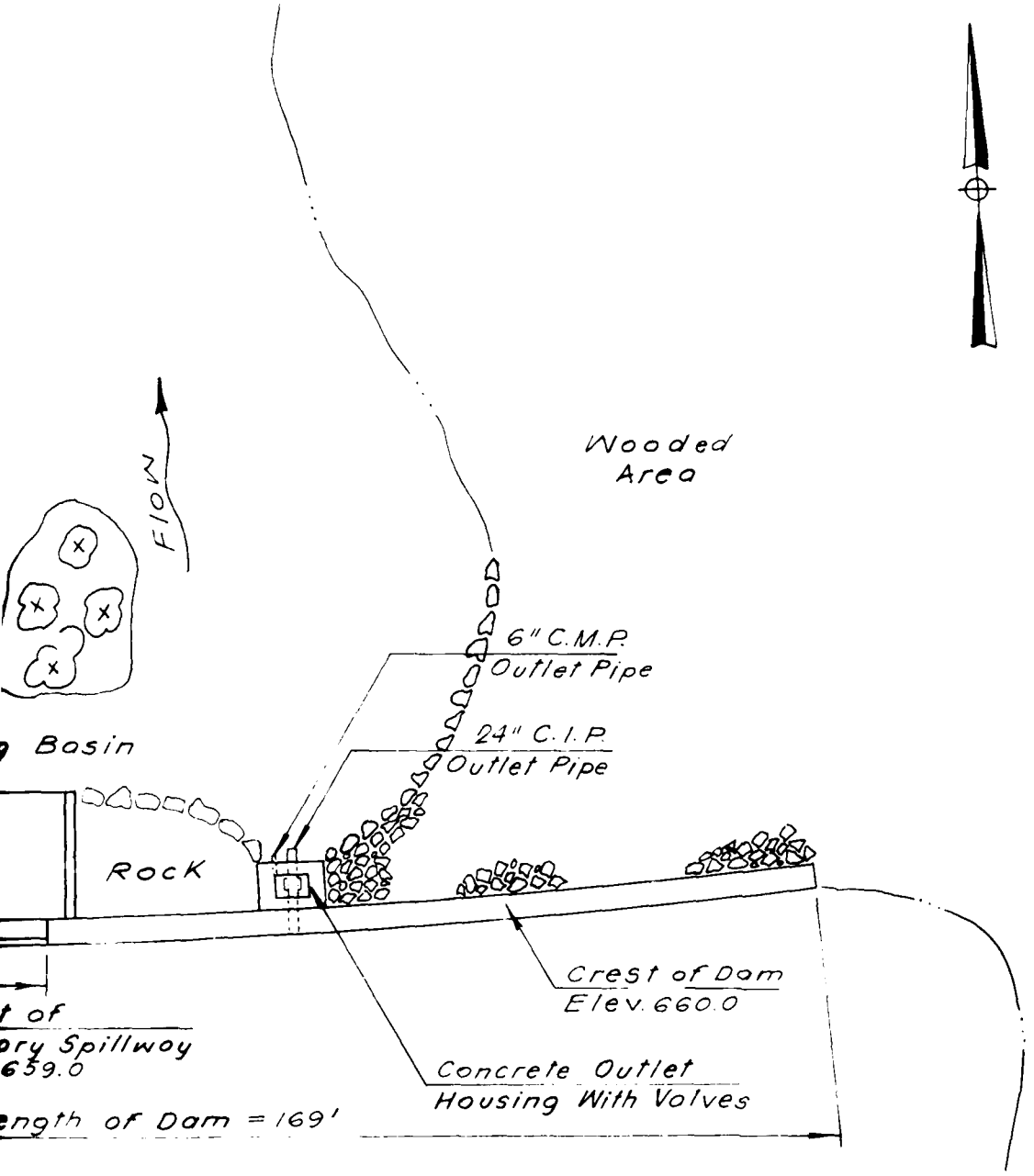


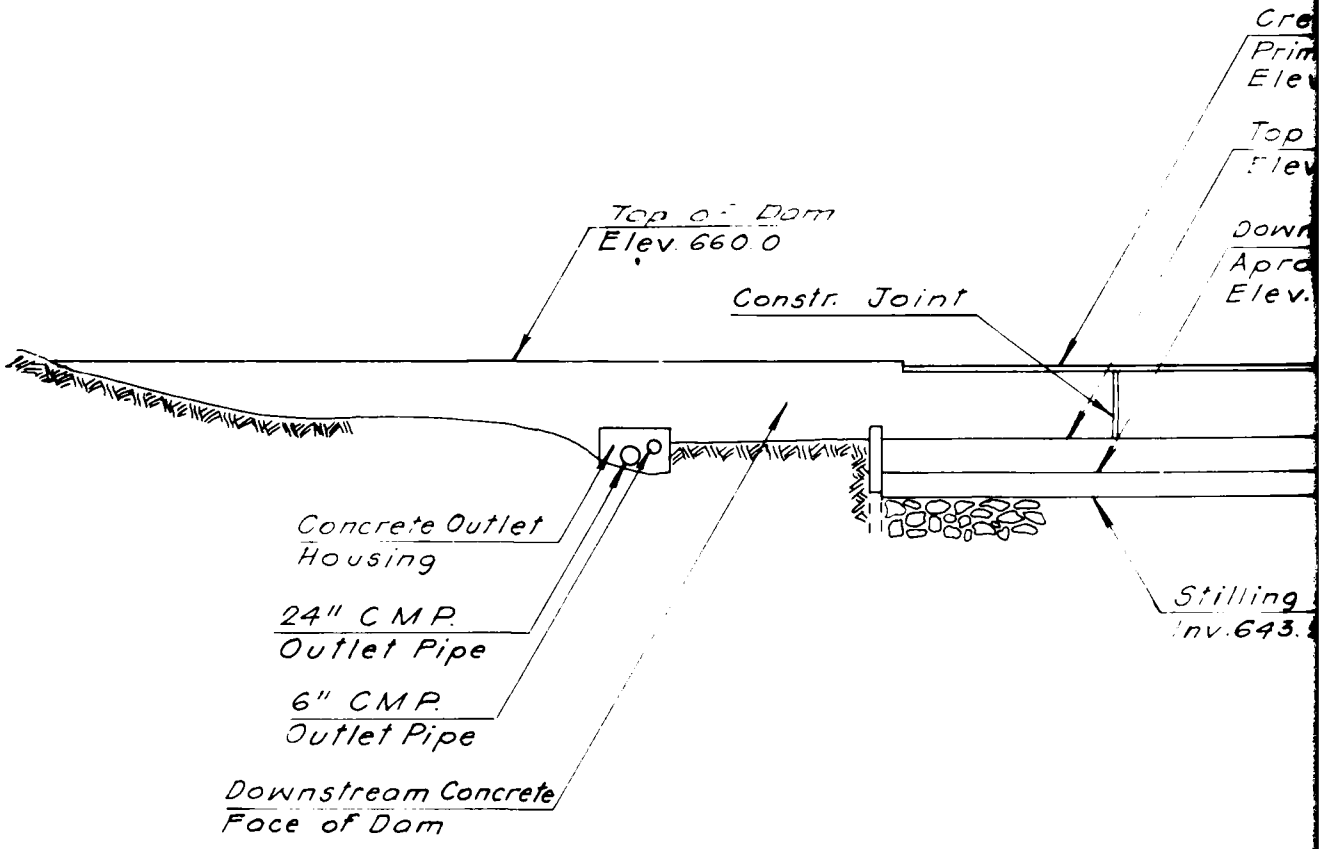
PLATE 4

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN
LOWER KAKEOUT DAM

NJ ID 00822	SCALE: NOT TO SCALE
	DATE: FEB. 1981


Cre
Prim
Ele
Top
Elev
Down
Apro
Elev.
Top of Dam
Elev. 660.0
Constr. Joint
Concrete Outlet
Housing
24" C M P.
Outlet Pipe
6" C M P.
Outlet Pipe
Downstream Concrete
Face of Dam
Stilling
Inv. 643.

1 horizontal to 1 vertical. The breach peak outflow was computed

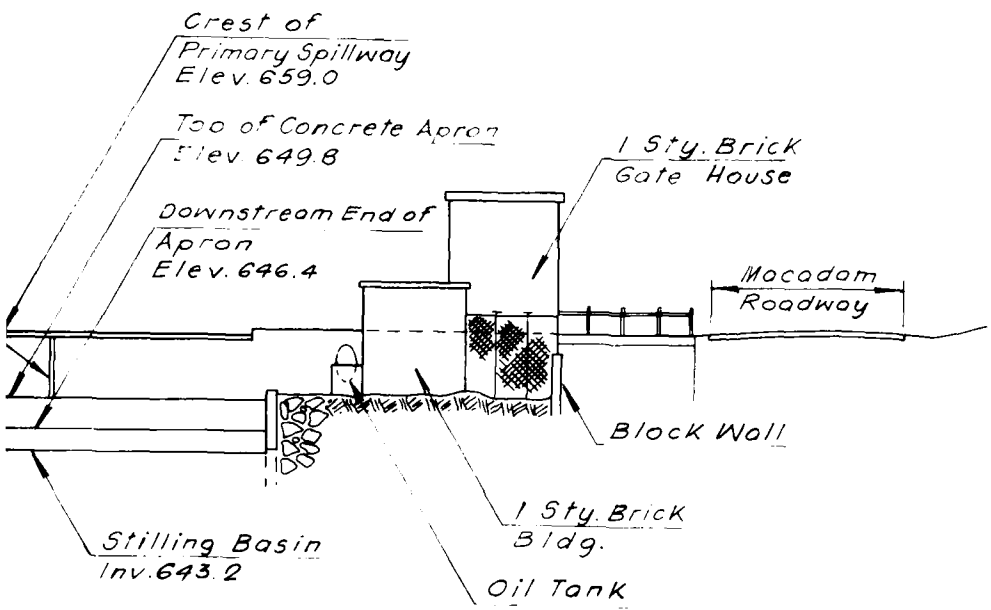


PLATE 5

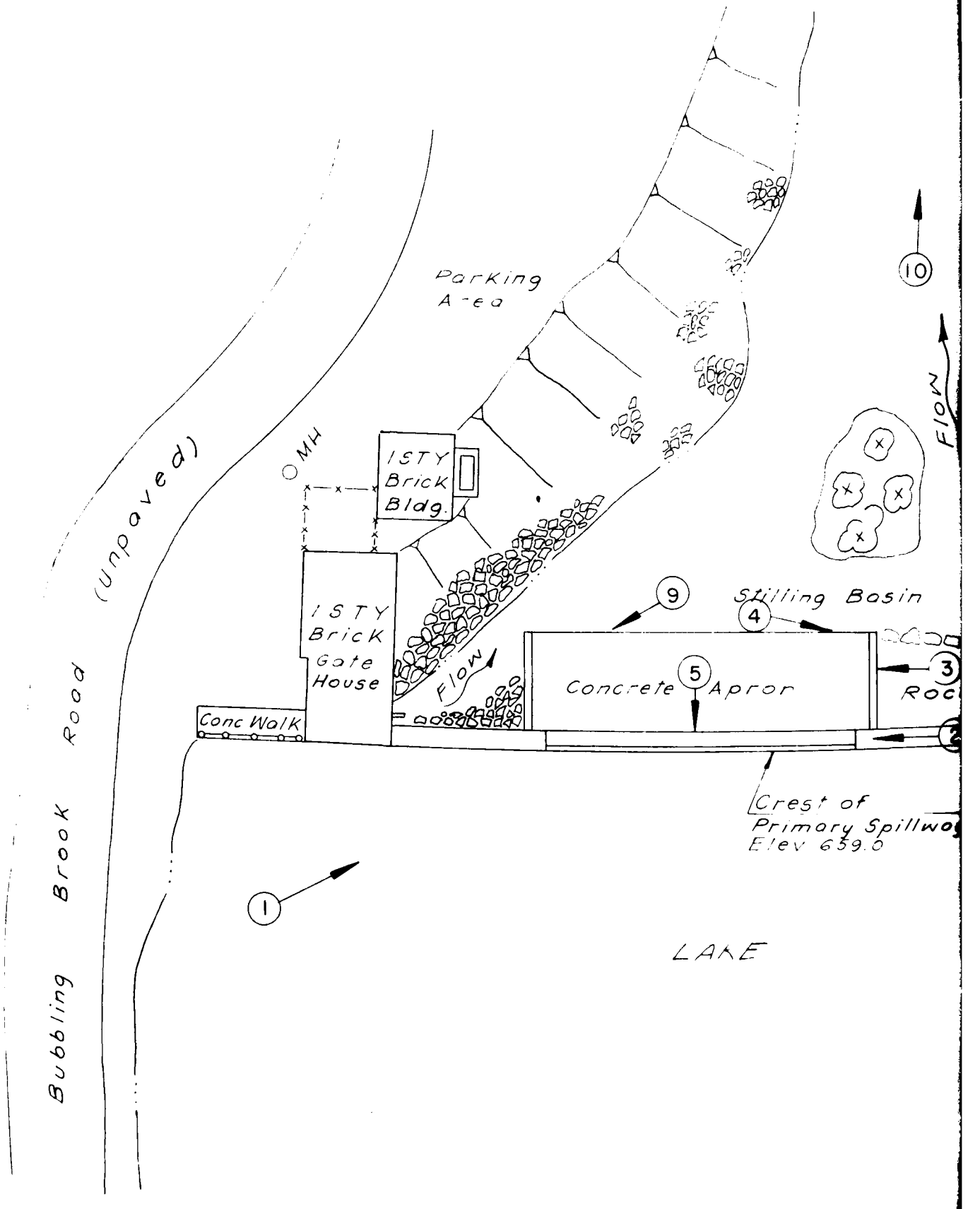
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

DOWNSTREAM ELEVATION

LOWER KAKEOUT DAM

N.J. I.D. 00822	SCALE: NOT TO SCALE
	DATE: FEB. 1981


Parking
Area
10
FLOW
MH
1 STY
Brick
Bldg.
1 STY
Brick
Gate
House
9
Stilling Basin
4
Concrete
5
Apron
3
Conc Walk
FLOW
Crest of
Primary Spillway
Elev 659.0
1
LAKE
Bubbling Brook Road (unpaved)

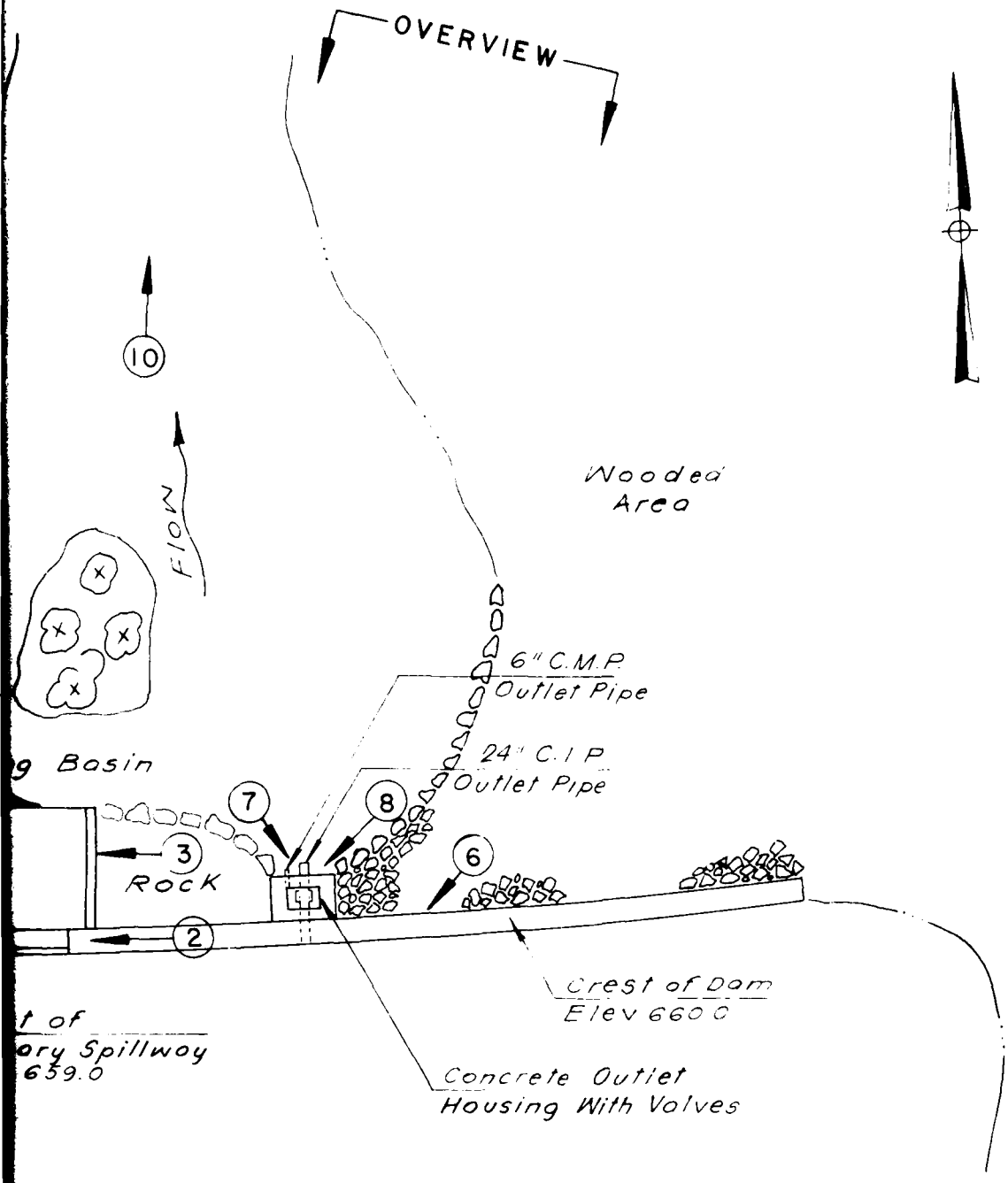


PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN
LOWER KAKEOUT DAM

NJ ID 00822	SCALE NOT TO SCALE
	DATE FEB. 1981

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List

Visual Inspection

Phase I

Name of Dam Lower Kakeout Dam County Morris State N.J. Coordinators NJDEP

Date(s) Inspection 12/18/80 Weather P. Cloudy Temperature 30°F.

Pool Elevation at time of Inspection 657.0 M.S.L. Tailwater at Time of Inspection 643.2 M.S.L.

Inspection Personnel:

John Gribbin Andrew Polperio

Charles Osterkorn Richard McDermott

Daniel Buckelew

John Gribbin Recorder

Owners Representative not present

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Dam appeared generally stable with extensive concrete deterioration including spalling, erosion, exudation, incrustation and surface cracks. Brick building at left end of dam appeared to be gate house and appeared to be in generally satisfactory condition.	The extensive concrete spalling, erosion, exudation, incrustation, and cracking should all be properly repaired.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Appeared sound.	
DRAINS	None observed.	
WATER PASSAGES	Cast iron pipe observed protruding from gate house at left end of dam. Water was flowing from pipe (about 15 gal./min.)	
APRON	Concrete apron at spillway section generally stable but containing significant spalling. One large spall (5' x 3') located adjacent to vertical joint in dam. Rocks with average size of 18" placed at toe form apron between conc. apron and outlet works.	Significant spalling and one large spall located adjacent to vertical joint in dam should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT	Vertical: level. Horizontal: curved.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Downstream face significantly spalled and cracked. Severe exudation and incrustation noted along right portion. One spall at right end - more than 6" deep. Crest spalled and eroded along right portion and about 15' left of spillway section. Upstream face spalled above waterline.	Deteriorated concrete should be repaired.
STRUCTURAL CRACKING	None observed.	
CONSTRUCTION JOINTS	Vertical joint on downstream side in center of spillway section. Movement of water could be heard within joint. Horizontal joint at downstream end of apron - leakage emerging along joint, flowing with a trickle. Horizontal joint in gate housing appeared to have opened slightly. Horizontal joint on downstream side of dam near crest significantly spalled.	
MONOLITH JOINTS	N.A.	
LEAKAGE	One point on downstream side about 15' right of outlet exhibited leakage slowly emerging through concrete. Leakage observed trickling through horizontal joint in downstream end of apron.	All leakage through concrete joints and throughout dam should be monitored on a periodic basis.
SEEPAGE	Seepage observed trickling through rocks adjacent to right, downstream end of apron.	Observed leakage through rocks should be monitored on a periodic basis.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduits appeared to be in generally satisfactory condition although rusted. The larger pipe had a scale of rust exposed.	Outlet conduits cast iron pipes.
INTAKE STRUCTURE	Not observed.	
OUTLET STRUCTURE	N.A.	
OUTLET CHANNEL	Outlet discharges directly into downstream channel.	
GATE AND GATE HOUSING	Concrete gate housing appeared sound although it was spalled and chipped at its edges. A horizontal construction joint appeared to have opened slightly. Both pipes appeared to be leaking slightly. Gate operating mechanisms appeared generally intact although rusted and pitted. They did not appeared to.have been recently operated.	Outlet works should be investigated for operational adequacy.

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Concrete surfaces generally sound but spalled.	Spillway consists of notch in crest of dam.
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Spillway discharges onto concrete apron and then into downstream channel.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Shore slopes wooded and steep with grades of about 50%.	
SEDIMENTATION	Unknown.	
STRUCTURES ALONG BANKS	None observed. Dam (Käkeout Reservoir Dam) at upstream end of lake.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTION, DEBRIS, ETC.)	Natural stream with bed lined with boulders. No significant obstructions observed.	
SLOPES	Banks wooded and very steep and high.	
STRUCTURES ALONG BANKS	Approx. 5 dwellings located along channel about 900 feet downstream from dam. Road bridge located about 1400 feet downstream from dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM			REMARKS
DAM	-	PLAN	Not Available
		SECTIONS	
SPILLWAY	-	PLAN	Not Available
		SECTIONS	
		DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS			Not Available
OUTLETS	-	PLAN	Not Available
		DETAILS	
		CONSTRAINTS	
		DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA			Not Available
RAINFALL/RESERVOIR RECORDS			Not Available
CONSTRUCTION HISTORY			Not Available
LOCATION MAP			Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM INSTABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	Not Available
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
MAINTENANCE OPERATION RECORDS	Not Available

APPENDIX 2

Photographs

PHOTO 1
UPSTREAM SIDE OF DAM

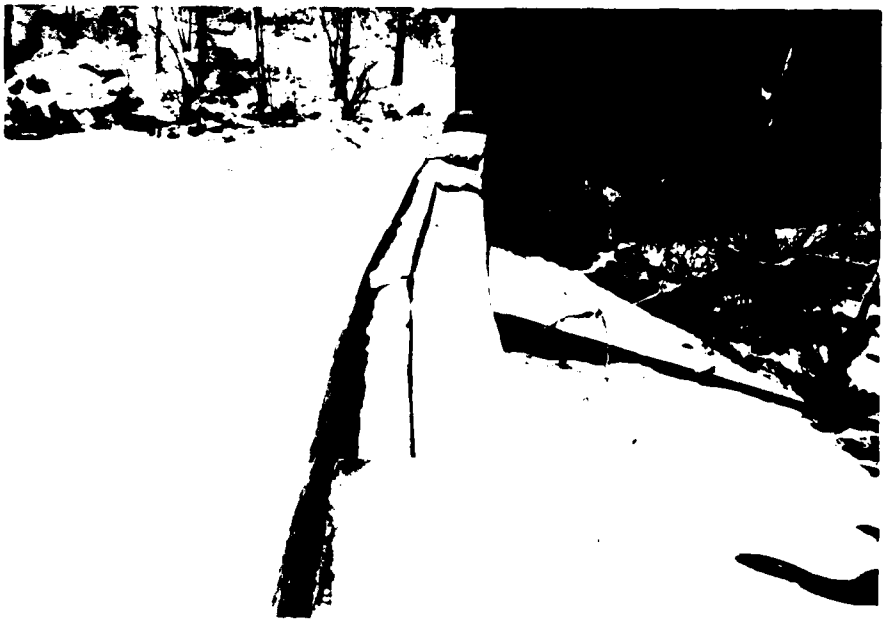


PHOTO 2
PRIMARY SPILLOVER SECTION OF DAM

LOWER KAKEOUT DAM
18 DECEMBER 1980

PHOTO 3

DOWNSTREAM SIDE OF DAM AND APRON
AT PRIMARY SPILLOVER SECTION

PHOTO 4

DOWNSTREAM SIDE OF DAM - RIGHT PORTION

LOWER KAKEOUT DAM
16 DECEMBER 1980

PHOTO 5

JOINT IN CENTER OF PRIMARY SPILLOVER SECTION OF DAM

PHOTO 6

DETEROIRATION ON DOWNSTREAM FACE OF DAM

LOWER KAKEOUT DAM
18 DECEMBER 1980

PHOTO 7
VALVE FOR OUTLET WORKS

PHOTO 8
DISCHARGE END OF OUTLET WORKS

LOWER KAKEOUT DAM
18 DECEMBER 1980

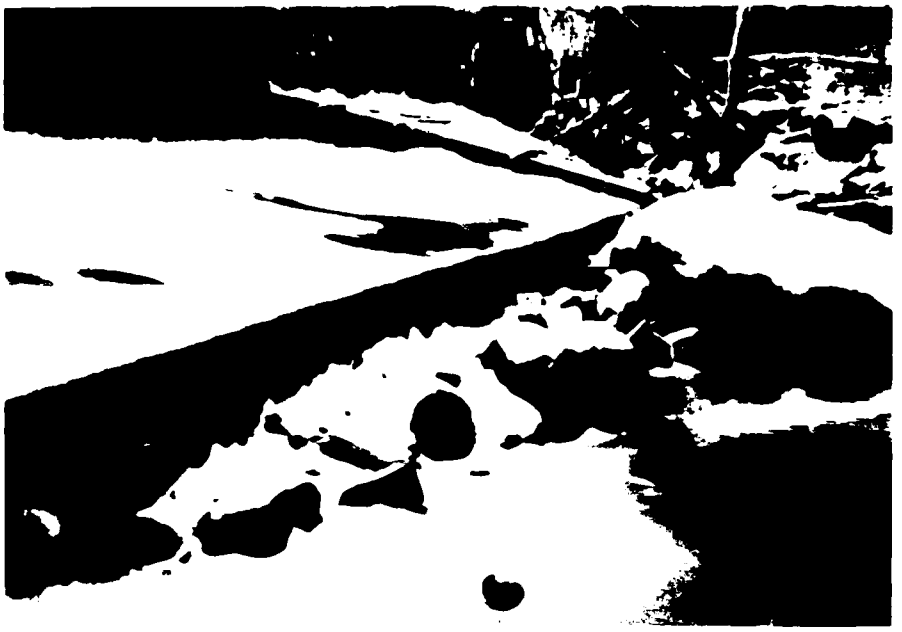


PHOTO 9
DOWNSTREAM END OF APRON

PHOTO 10
DOWNSTREAM CHANNEL

LOWER KAKEOUT DAM
18 DECEMBER 1980

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded with reservoir upstream

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 657.0 (41 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 664.8

ELEVATION TOP DAM: 660.0

SPILLWAY CREST: Notch in crest of dam

a. Elevation 659.0

b. Type Broad crested weir

c. Width 3.0 feet

d. Length 49.5 feet

e. Location Spillover Downstream side of dam

f. Number and Type of Gates None

OUTLET WORKS:

a. Type Two gated pipes - 24" CMP & 6" CMP

b. Location 50 feet right of spillway

c. Entrance Invert Unknown

d. Exit Invert 644.4 (24" CMP)

e. Emergency Draindown Facilities: Open gate

HYDOMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake Stage Equal to Top of Dam) 148 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

STORCH ENGINEERS

Sheet 1 of 11

Project LOWER KAKEOUT DAM

Made By JLP Date 3-18-81

Chkd By JG Date 4/15/81

HYDROLOGY

DRAINAGE AREA = 5.93 SQ. MI.

THE FOLLOWING 1/2 P.M.F. INFLOW HYDROGRAPH WILL BE USED. SUPPLIED BY THE U.S. ARMY CORPS OF ENGINEERS.

TIME (HOURS)	FLOW (CFS)
1	2
2	29
3	129
4	499
5	3934
6	5859
7	4501
8	2635
9	1429
10	885
11	724
12	628
13	542
14	466
15	407
16	361
17	320
18	284
19	252
20	224
21	198
22	176
23	156
24	144

STORCH ENGINEERS

Project LOWER KAKEOUT DAM

Sheet 2 of 11

Made By JLP Date 3-18-81

Chkd By JG Date 4/15/81

LAKE STORAGE VOLUME

ELEVATION	AREA (ACRES)
643.2	0
657.0	4.59
680.0	190.1
700.0	227.7

HEC-1-DAM COMPUTER PROGRAM WILL DEVELOP STORAGE CAPACITY FROM SURFACE AREAS AND ELEVATIONS.

INFORMATION TAKEN FROM USGS QUADRANGLE POMPTON PLAINS, N.J.

HYDRAULICS

THE SPILLWAY AT LOWER KAKEOUT DAM CONSISTS OF A BROAD CRESTED CONCRETE WEIR. WITH AN EFFECTIVE LENGTH OF 49.5' AND A CREST ELEVATION OF 659.0. DISCHARGE Q, CAN BE CALCULATED BY:

$$Q = cLh^{3/2}$$

where:

Q = discharge over spillway
c = discharge coefficient
L = effective length of spillway
h = total head on spillway

Values for the discharge coefficient "c" were taken from the "Handbook of Hydraulics" by King & Brater.

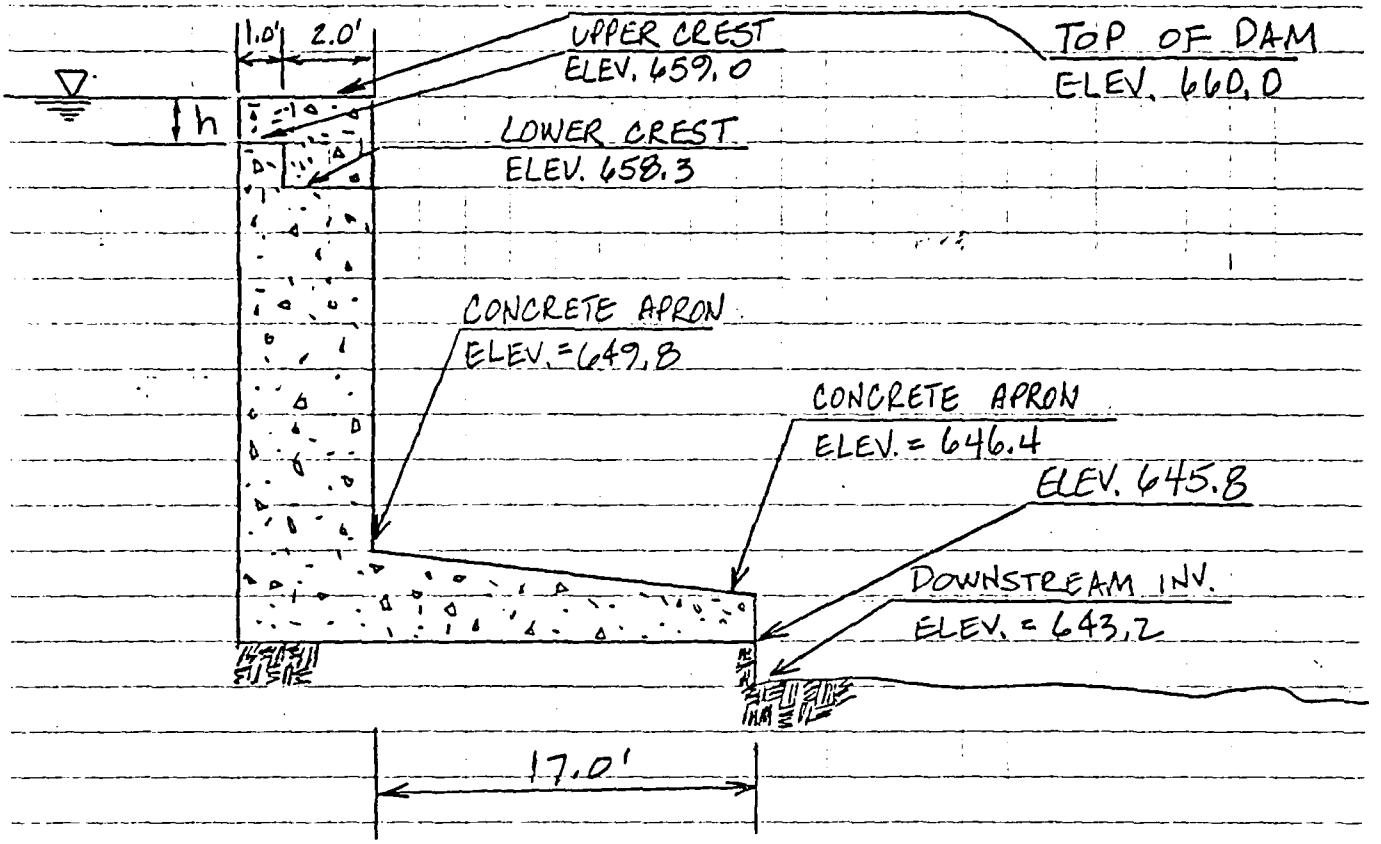
STORCH ENGINEERS

Project LOWER KAKEOUT DAM

Sheet 4 of 11

Made By JLP Date 3-17-81

Chkd By JG Date 4/15/81



SPILLWAY STAGE DISCHARGE TABULATION

PRINCIPAL SPILLWAY				
ELEV.	C	L	H	Q
659.0		49.5		
659.5	2.74	49.5	0.5	47.9
660.0	2.98	49.5	1.0	147.5
661.0	3.30	49.5	2.0	462.0
662.0	3.32	49.5	3.0	853.9
663.0	3.32	49.5	4.0	1314.7
664.0	3.32	49.5	5.0	1837.4
665.0	3.32	49.5	6.0	2415.3
666.0	3.32	49.5	7.0	3043.6
667.0	3.32	49.5	8.0	3718.4

STORCH ENGINEERS

Project LOWER LAKEOUT DAM

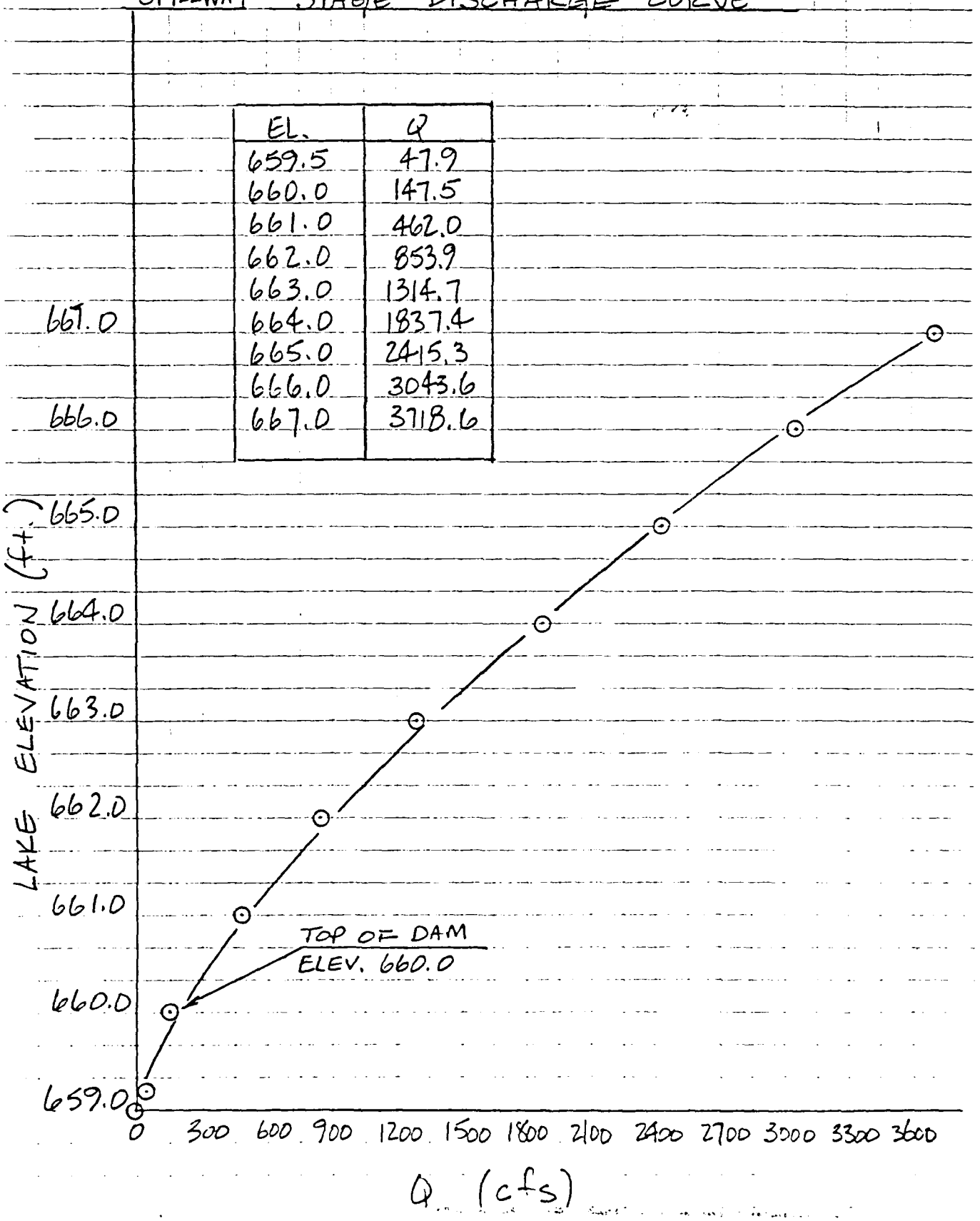
Sheet 5 of 11

Made By JLP Date 3-18-31

Chkd By JG Date 4/15/21

SPILLWAY STAGE DISCHARGE CURVE

EL.	Q
659.5	47.9
660.0	147.5
661.0	462.0
662.0	853.9
663.0	1314.7
664.0	1837.4
665.0	2415.3
666.0	3043.6
667.0	3718.6



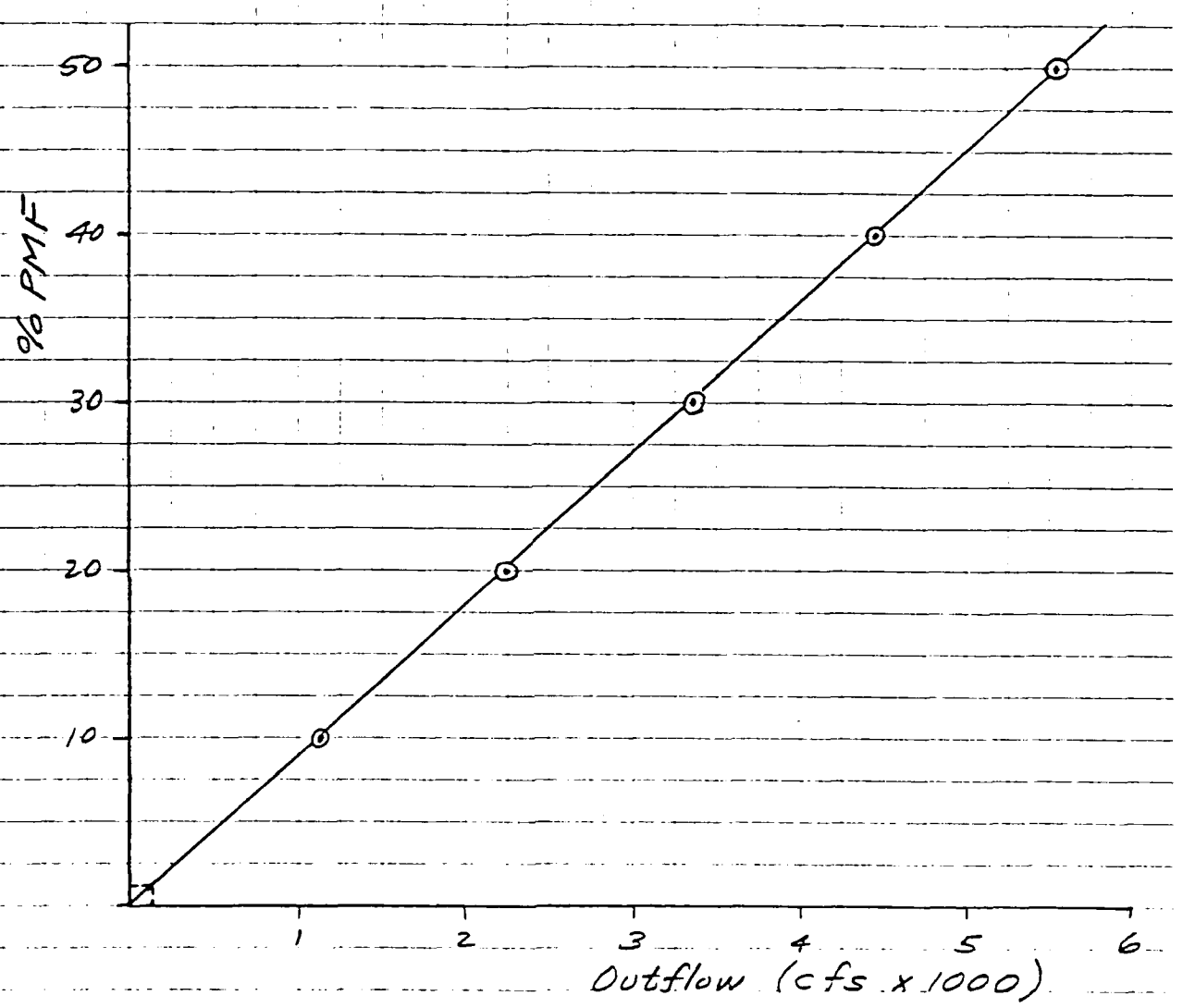
STORCH ENGINEERS

Sheet 6 of 11

Project LOWER KAKEOUT DAM Made By JG Date 4/17/81

Chkd By _____ Date _____

OVERTOPPING POTENTIAL



Dam overtopping occurs at elev. 660.0 with a discharge Q = 148 c.f.s.

The dam can pass approx. 1% PMF

DRAWDOWN CAPACITY

Outlet works consist of a 24 inch and a 6 inch C.I.P. Discharge is computed using "Hydraulic Charts for the Selection of Highway Culverts," Bureau of Public Roads, 1963, assuming inlet control.

Maximum discharge, HW = 14.6'

Q = 60 cfs

Average discharge HW = 7.3'

Q = 30 total both pipes

Drawdown

$$\text{Drawdown time} = \frac{\text{Storage at Spillway}}{\text{Avg. Discharge} - \text{Avg. Inflow}}$$

$$= \frac{41 \text{ acre-ft.} \times 43560 \text{ sq.ft/acre}}{(30\text{cfs} - 6\text{cfs}) \times 3600 \text{ sec./hr.}}$$

$$= 20.7 \text{ hr.}$$

STORCH ENGINEERS

Sheet 8 of 11

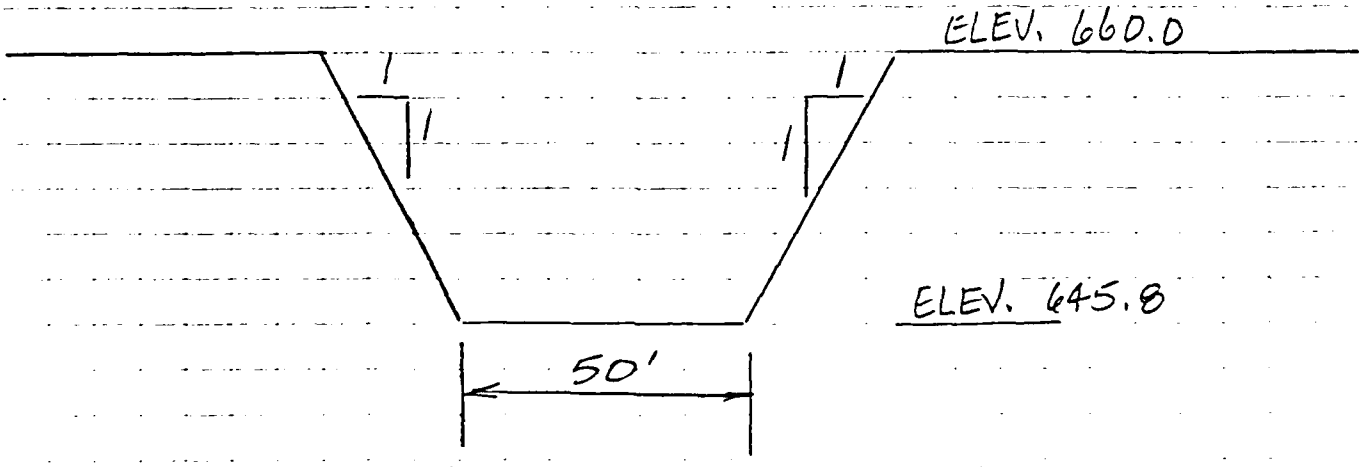
Project LOWER KALEDUT DAM Made By _____ Date _____

Chkd By JG Date 4/15/81

BREACH ANALYSIS

A BREACH HYDROGRAPH WILL BE COMPUTED BY THE HEC-1-DAM PROGRAM AND ROUTED THROUGH TWO DOWNSTREAM REACHES BY THE MODIFIED PULS METHOD. THE ASSUMED BREACH CONDITIONS ARE AS FOLLOWS:

1. THE BREACH BEGINS WHEN THE WATER SURFACE ELEVATION REACHES 660.0
2. TIME TO DEVELOP BREACH = 2.0 HR.
3. SECTION:



FULLY DEVELOPED BREACH

STORCH ENGINEERS

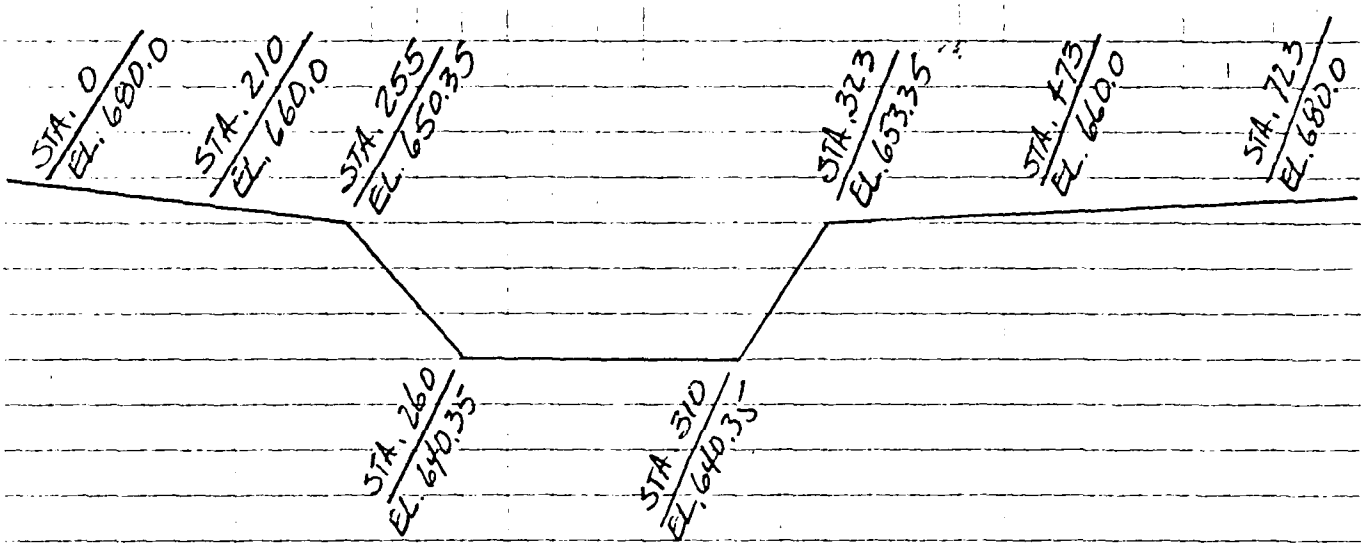
Sheet 9 of 11

Project LOWER KAKEOUT DAM

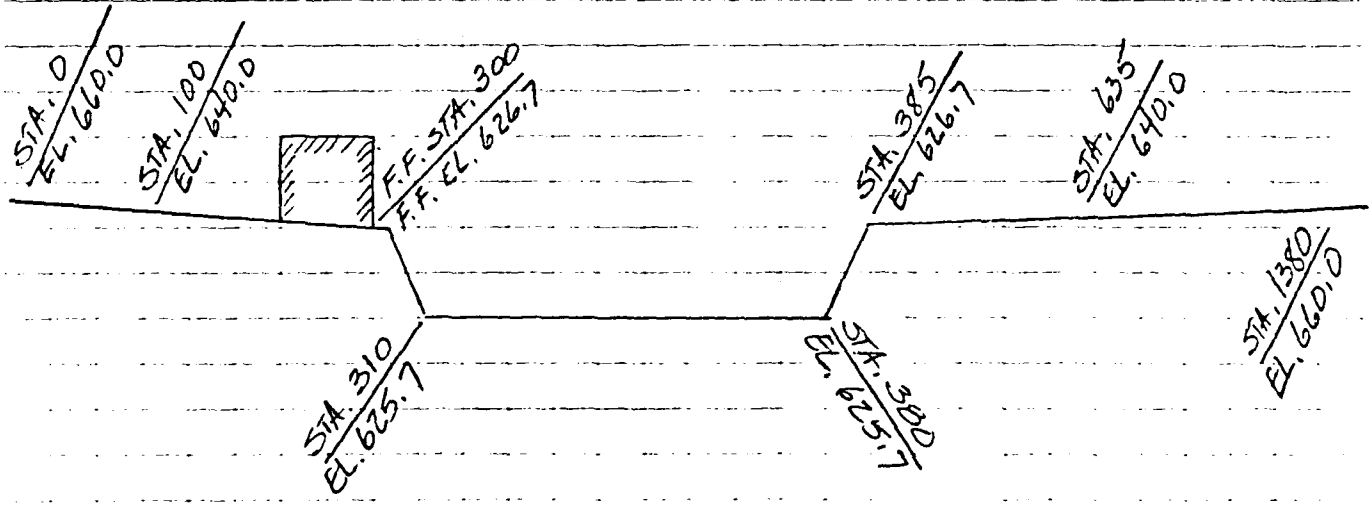
Made By JLP Date 3-18-81

Chkd By JG Date 4/15/81

END OF REACH 1 CROSS SECTION 100' DOWNSTREAM



END OF REACH 2 CROSS SECTION 900' DOWNSTREAM



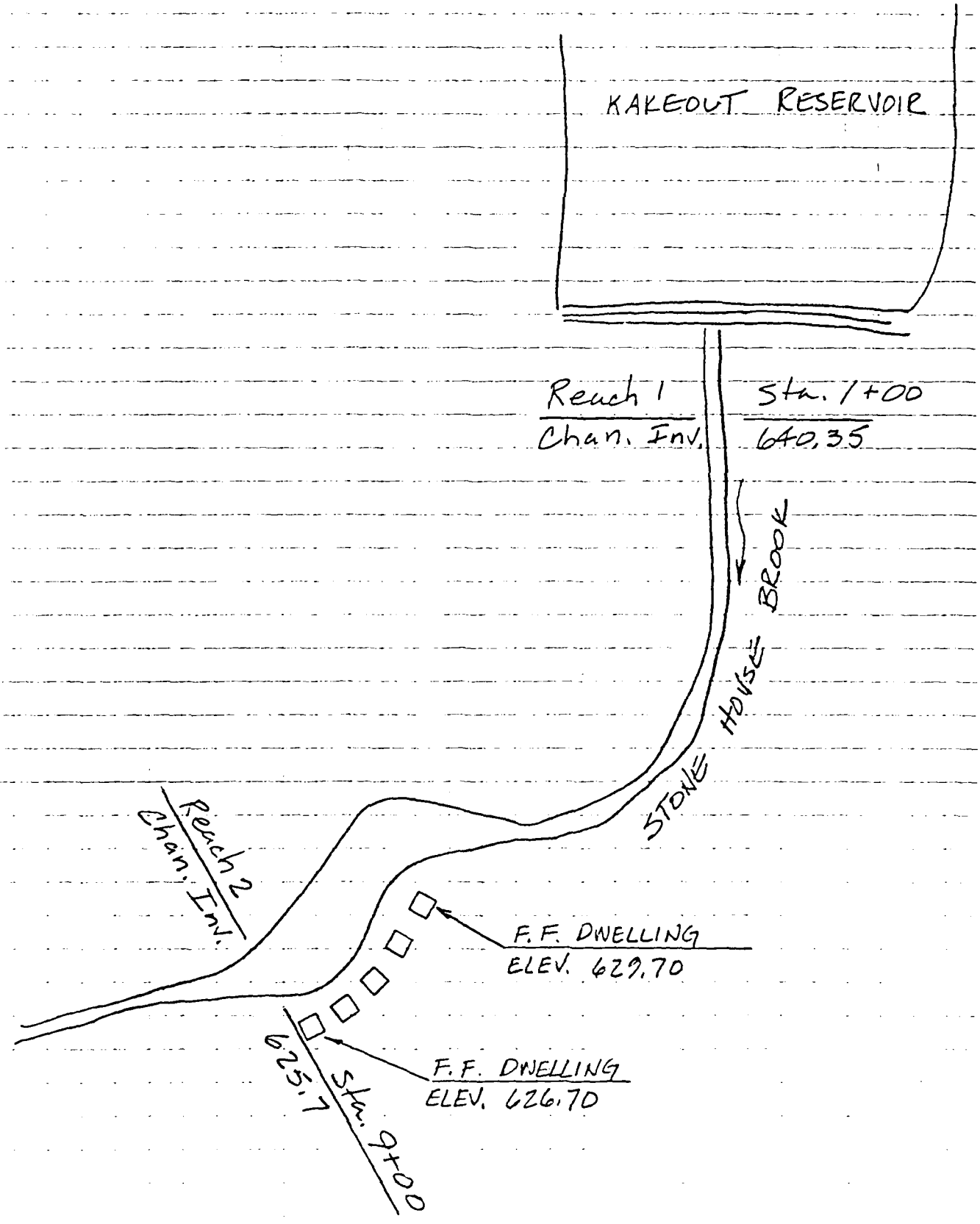
STORCH ENGINEERS

Project LOWER KAKEOUT DAM

Sheet 10 of 11

Made By JLP Date 5-18-81

Chkd By JG Date 4/15/81



BREACH RESULTS:

Max. Outflow = 6137 c.f.s.

Reach 1: Max. Stage = 649.1
Stream Inv. = 640.4

Reach 2: Max. Stage = 629.6
Stream Inv. = 625.7

About 4 dwellings inundated up to 2.9'

RESULTS WITHOUT BREACH

Max. Outflow = 5542 c.f.s.

Reach 1: Max. Stage = 648.6
Stream INV. = 640.4

Reach 2: Max. Stage = 629.4
Stream INV. = 625.7

About 4 dwellings inundated up to 2.7'

HEC - 1 - DAM PRINTOUT

Overtopping Analysis

```
1A1                    NATIONAL DAM SAFETY PROGRAM
 A2                LOWER KAKEOUT RESERVOIR DAM, NEW JERSEY
 A3                      MULTI RATIO ROUTING
 B     30       1       0                                                4
 B1     5
 J      1       5       1
 J1   1.0    0.80    0.60    0.40    0.20
 K      0    LAKE                       0       0       1
 K1         INFLOW HYDROGRAPH TO KAKEOUT RESERVOIR DAM
 H     -1            5.93            5.93
 N      2      29     129     499    3934    5859    4501    2635    1429     885
 N    724     628     542     466     407     361     320     284     252     224
 N    198     176     156     144
 K      1     DAM
 K1         ROUTE DISCHARGE THROUGH DAM
 Y                                      1       1
 Y1     1                                       --  -659.0      -1
 Y4 659.0   659.5   660.0   661.0   662.0   663.0   664.0   665.0   666.0   667.0
 Y5     0    47.9   147.5   462.0   853.9  1314.7  1837.4  2415.3  3043.6  3218.6
 $A     0     2.0    4.59   190.1   227.7
 $E 643.2     650     657     680     700
 $$-659.0
 $D 660.0    2.63     1.5   119.5
 K      1       1                                               1
 K1       CHANNEL ROUTING REACH 1
 Y                                      1       1
 Y1     1
 Y6   0.1   0.035     0.1   640.4     680     100  0.0064
 Y7     0     680     210     660     255   650.4     260   640.4     310   640.4
 Y7   323   650.4     473     660     723     680
 K      1       2                                               1
 K1       CHANNEL ROUTING REACH 2
 Y                                      1       1
 Y1     1
 Y6   0.1   0.035     0.1   625.7     660     850  0.0285
 Y7     0     660     100     640     300   626.7     310   625.7     380   625.7
 Y7   385   626.7     635     640    1380     660
 K     99
```

NATIONAL DAM SAFETY PROGRAM
LOWER KAKEOUT [redacted] DAM, NEW JERSEY
MULTI RATIO ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
30	1	0	0	0	0	0	0	4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN-ANALYSES-TO-BE-PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= 1.00 .80 .60 .40 .20

****

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO KAKEOUT [redacted] DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	5.93	0.00	5.93	0.00	0.000	0	0	0

****

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-659.	-1

STAGE	659.00	659.50	660.00	661.00	662.00	663.00	664.00	665.00	666.00	667.00
FLOW	0.00	47.90	147.50	462.00	853.90	1314.70	1837.40	2415.30	3043.60	3718.60
SURFACE AREA=	0.	2.	5.	190.	228.					
CAPACITY=	0.	5.	27.	1746.	5918.					
ELEVATION=	643.	650.	657.	680.	700.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
659.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
660.0	2.6	1.5	120.

PEAK OUTFLOW IS 5542. AT TIME 6.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS				
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	.80	.60	.40	.20
HYDROGRAPH AT	LAKE	5.93	1	5859.	4687.	3515.	2344.	1172.
		(15.36)		(165.91)(	132.73)(	99.55)(	66.36)(	33.18)(
ROUTED TO	DAM	5.93	1	5542.	4455.	3365.	2265.	1144.
		(15.36)		(156.93)(	126.15)(	95.29)(	64.12)(	32.40)(
ROUTED TO	1	5.93	1	5542.	4456.	3367.	2265.	1144.
		(15.36)		(156.94)(	126.19)(	95.34)(	64.15)(	32.40)(
ROUTED TO	2	5.93	1	5541.	4460.	3376.	2260.	1129.
		(15.36)		(156.89)(	126.30)(	95.60)(	64.01)(	31.98)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	659.00	659.00	660.00
STORAGE	41.	41.	53.
OUTFLOW	0.	0.	148.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	664.76	4.76	168.	5542.	21.00	6.00	0.00
.80	664.07	4.07	144.	4455.	19.00	6.00	0.00
.60	663.31	3.31	121.	3365.	15.00	6.00	0.00
.40	662.45	2.45	98.	2265.	12.00	6.00	0.00
.20	661.41	1.41	76.	1144.	7.00	6.00	0.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5542.	648.6	6.00
.80	4456.	647.5	6.00
.60	3367.	646.4	6.00
.40	2265.	645.1	6.00
.20	1144.	643.4	6.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	5541.	629.4	6.00
.80	4460.	628.9	6.00
.60	3376.	628.4	6.00
.40	2260.	627.9	6.00
.20	1129.	627.0	6.00

HEC - 1 - DAM PRINTOUT

Breach Analysis

```
1A1 ---------- NATIONAL DAM SAFETY PROGRAM ----------
A2                LOWER  KIKEOUT RESERVOIR DAM, NEW JERSEY
A3                       MULTI RATIO ROUTING
B    30      1       0                                                   4
B1    5
J     1       5       1
J1  1.0    0.80    0.60    0.40    0.20
K     0    LAKE                      0       0       1
K1       INFLOW HYDROGRAPH TO KIKEOUT RESERVOIR DAM
N     1                 5.93            5.93
N     2      29     129     499    3934    5859    4501    2635    1429     885
N   724     628     542     466     407     361     320     284     252     224
N   198     176     156     144
K     1    DAM
K1       ROUTE DISCHARGE THROUGH DAM
Y                                       1       1
Y1    1                                                 -659.0      -1
Y4 659.0   659.5   660.0   661.0   662.0   663.0   664.0   665.0   666.0   667.0
Y5    0    47.9   147.5   462.0   853.9  1314.7  1837.4  2415.3  3043.6  3718.6
$A    0     2.0    4.59   190.1   227.7
$E 643.2     650     657     680     700
$$ 659.0
$D 660.0    2.63     1.5   119.5
$B   50       1   645.8     2.0   659.0   660.0
K     1       1                                       1
K1       CHANNEL ROUTING REACH 1
Y                                       1       1
Y1    1
Y6  0.1   0.035     0.1   640.4     680     100  0.0064
Y7    0     680     210     660     255   650.4     260   640.4     310   640.4
Y7  323   650.4     473     660     723     680
K     1       2                                       1
K1       CHANNEL ROUTING REACH 2
Y                                       1       1
Y1    1
Y6  0.1   0.035     0.1   625.7     660     850  0.0285
Y7    0     660     100     640     300   626.7     310   625.7     380   625.7
Y7  385   626.7     635     640    1380     660
K    99
```

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-659.	-1

STAGE	659.00	659.50	660.00	661.00	662.00	663.00	664.00	665.00	666.00	667.00
FLOW	0.00	47.90	147.50	462.00	853.90	1314.70	1832.40	2415.30	3043.60	3718.60
SURFACE AREA=	0.	2.	5.	190.	228.					
CAPACITY=	0.	5.	27.	1746.	5918.					
ELEVATION=	643.	650.	657.	680.	700.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
659.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
660.0	2.6	1.5	120.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	645.80	2.00	659.00	660.00

BEGIN DAM FAILURE AT 4.00 HOURS

PEAK OUTFLOW IS 6137. AT TIME 6.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS				
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	.80	.60	.40	.20
HYDROGRAPH AT	LAKE	5.93	1	5859.	4687.	3515.	2344.	1172.
		(15.36)	(	165.91)(	132.73)(	99.55)(	66.36)(	33.18)(
ROUTED TO	DAM	5.93	1	6137.	4936.	4055.	2966.	1788.
		(15.36)	(	173.78)(	139.79)(	114.83)(	83.99)(	50.64)(
ROUTED TO	1	5.93	1	6145.	4945.	4056.	2965.	1785.
		(15.36)	(	174.00)(	140.03)(	114.85)(	83.96)(	50.55)(
ROUTED TO	2	5.93	1	6204.	5003.	4050.	2944.	1746.
		(15.36)	(	175.67)(	141.68)(	114.69)(	83.37)(	49.44)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	659.00	659.00	660.00
STORAGE	41.	41.	53.
OUTFLOW	0.	0.	140.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	660.84	.84	66.	6137.	2.24	6.00	4.00
.80	660.55	.55	61.	4936.	2.00	6.00	4.00
.60	661.90	1.90	86.	4178.	2.12	6.20	5.00
.40	661.33	1.33	74.	3049.	1.88	6.16	5.00
.20	660.63	.63	62.	1800.	1.56	5.96	5.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	6145.	649.1	6.00
.80	4945.	648.0	6.00
.60	4056.	647.1	6.00
.40	2965.	646.0	6.00
.20	1785.	644.5	6.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	6204.	629.6	6.00
.80	5003.	629.2	6.00
.60	4050.	628.7	6.00
.40	2944.	628.2	6.00
.20	1746.	627.6	6.00

APPENDIX 5

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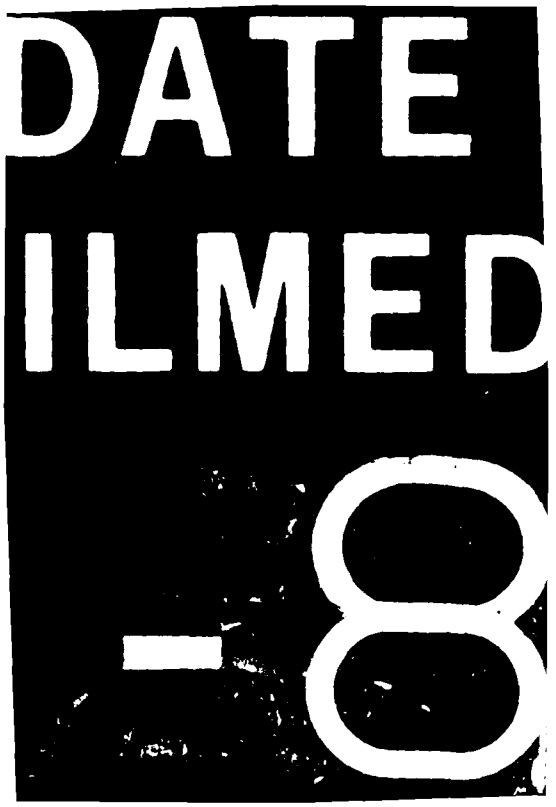
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